U.S. DEPARTMENT OF COMMERCE
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PB-259 642-T

THE FUNCTIONAL STATE OF THE HIPPOCAMPUS DURING PROLONGED IMPULSE AND STABLE NOISE

Environmental Protection Agency
Research Triangle Park, North Carolina

1972

PB 259 642-T

321002

EPA.TR-275

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(O funktsional'nom sostoyanii gippokampa pri dlitel'nom vozdeystvii impul'snogo i stabil'nogo shuma)

G. A. Suvorov

Gigiena i Sanitariya, June 1972, No. 6, pp. 29-31

Translated for EPA by
SCITRAN (SCIENTIFIC TRANSLATION SERVICE)
SANTA BARBARA, CALIFORNIA

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NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

BIBLIOGRAPHIC DATA SHEET	1. Report No. EPA TR73-275	2.	3. Recipient's Accession No.
4. Title and Subtitle: The functional state of the hippocampus during prolonged impulse and stable noise.			5. Report Date 1972 6.
7. Author(s): G.A. Suvorov			8. Performing Organization Rept. No.
9. Performing Organization Name and Address: TRANSLATED FROM RUSSIAN BY EPA			10. Project/Task/Work Unit No. 11. Contract/Grant No.
12. Sponsoring Organization Name and Address: Translation Service, Office of Administration - Library, Research Triangle Park, NC 27711			13. Type of Report & Period Covered 14.

15. Supplementary Notes

GIGIENA I SANITARIYA, June 1972, No. 6, pp.29-31

16. Abstracts

17. Key Words and Document Analysis. 17a. Descriptors

EPAISD

17b. Identifiers/Open-Ended Terms

NOISE POLLUTION
MEDICAL RESEARCH

17c. COSATI Field/Group 06S 57W

18. Availability Statement: THIS TRANSLATION WAS MADE FROM A NON-COPYRIGHTED TEXT,..	19. Security Class (This Report) UNCLASSIFIED	21. No. of Pages 8
	20. Security Class (This Page) UNCLASSIFIED	22. Price $3.50 - 3.00

THE FUNCTIONAL STATE OF THE HIPPOCAMPUS DURING PROLONGED IMPULSE AND STABLE NOISE

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It has been shown that in the formation of the complete reaction of the brain, along with other systems, an active part is assumed by the limbic system, which integrates emotional motivation of behavior (Brady). The most important formation in this system is the hippocampus, which occupies a central position in the functional and anatomical relationships.

It was our purpose to make a comparative study in acute and chronic tests of the effect of impulse and stable noise on the functional state of the hippocampus. Tests were conducted on 27 rabbits into which deep bipolar discharging and stimulating electrodes were inserted under morphine-aminase narcosis. The electrodes were made of nichrome steel (150 μ in diameter) and insulated with glass. The ends of the electrodes were free of insulation for a length of 0.5 mm. The distance between electrodes was 1 mm. To record an electrocorticogram (EK_0G) from various areas of the cortex, needle-shaped electrodes were used, which were driven into the skull bone. The distance between them was 3-4 mm. Discharging and stimulating electrodes in the hippocampus were implanted by means of stereotaxic apparatus and oriented according to the coordinates of Sawyer et al. Biopotentials were recorded by a 4-channel encephalograph (4-EEG-1).

The index of the functional state of the dorsal hippocampus was its excitability, which was determined by the ratio of behavioral and electroencephalographic reactions, induced by threshold electrostimulation of this structure. A square-pulse generator with a high-frequency attachment was used to stimulate the hippocampus (frequency 50 Hz, length of impulse 1 msec., length of stimulation 5 sec.).

The noise stimulus was activated 60 minutes after thresholds of excitability were determined in this structure. Animals with free run of a screened cage were exposed to impulse noise in the form of an aperiodic sequence of square impulses, subject to Poisson law (average latency 2 sec., length of impulse 100 msec., intensity of impulse 100 dB). The effect of impulse noise was comparatively evaluated with that of stable white noise of equal average power, i.e. with a level of intensity of 87 dB.

In the acute test, bioelectric activity was recorded by its length and thresholds of excitability of the hippocampus were determined before the noise and then with a single stimulus after 1, 3 and 6 hours of noise exposure. In the chronic experiment, bioelectric activity was recorded periodically during 3 months of noise exposure and thresholds of excitability of the hippocampus determined both before the noise and after 3-hour tests throughout the 3-month experiment.

With threshold stimulation of the dorsal hippocampus (1-2 V), the electrogram (EG) of this structure recorded brief aftereffect discharges which often irradiated into the mesencephalic reticular formation. A defensive type reaction was observed at this time in the animals, characterized by watchfulness, tension and symptoms of pronounced anxiety. The rabbits uttered sounds and beat their back feet sharply against the floor of the cage. If the aftereffect discharges were local and brief and recorded only in the hippocampus, then behavioral reactions were most often clinically asymptomatic. The data we obtained completely agree with results of studies of F. P. Vedyaev and V. A. Krauz.

During acute experimental conditions excitation of the hippocampus is noted at all stages under the effect of the noise stimulus. However, depending on the character of the noise, excitability of the hippocampus changes in different ways. Impulse noise causes the most pronounced increase of excitability of this structure during the first hour of the test. Thresholds of behavioral and electroencephalographic reactions, induced by stimulation of the hippocampus, are reduced an average of 0.8±0.1 V. After 3 hours of the test, excitability of the hippocampus is slightly reduced in comparison with the previous stage of the experiment, but, nevertheless, remains elevated in comparison with control data. In this case, thresholds of hippocampal induced reactions average 0.6±

±0.1 V lower than the controls. After 6-hour exposure to impulse noise, excitability of the hippocampus is slightly changed but, nevertheless, at this stage of the test thresholds of induced behavioral and electroencephalographic reactions, due to stimulation of the hippocampus, are slightly lower than after 3 hours of noise.

Unlike impulse stimuli, an hour after activation of stable noise, the excitability of the hippocampus has changed insignificantly, although in tests a slight tendency toward stimulation of this brain structure is also noted. The most pronounced reduction of thresholds of excitability is noted after 3 hours, when the threshold of excitability of this formation is reduced an average of 0.7±0.1 V in comparison with initial values. After 6 hours of noise exposure, the hippocampus is slightly depressed in comparison with the previous stage of the experiment, i.e. the threshold of its excitability is reduced in comparison with the control 0.5±0.1 V.

Therefore, 6 hours of both impulse and stable noise, at all stages of the experiment, causes stimulation of the hippocampus. However, if maximum stimulation of the hippocampus is detected after 3 hours of stable noise, with impulse noise the sharpest stimulation occurs after the 1st hour of the test.

In chronic experiment, under the effect of impulse noise, the excitability of the hippocampus by the end of the 1st month of chronic experiment is slightly increased. However, the reduction of thresholds of excitability in weekly determination 24 hours after alternate 3-hour tests, in comparison with control indices, is unimportant ($P>0.05$). During the second and especially the third month of the experiment excitability of the hippocampus increases. The 23% reduction of hippocampal thresholds, noted at this stage, essentially differs from control tests in which threshold stimulation of the hippocampus was produced in the same length of time as in rabbits not exposed to noise.

Another picture is observed in tests in which the functional state of the hippocampus was studied directly at the end of each one. In this case, thresholds of induced behavioral and electroencephalographic reactions, reproducible during stimulation of this structure, are reduced in each specific case an average of 0.6±0.1 V ($P<0.05$). However, the increase of excitability of this formation during the 2nd and 3rd month of the experiment is slightly less pro-

nounced than during the first.

In contrast to the above, the excitability of the hippocampus during the first 30 days, when thresholds of induced behavioral and electroencephalographic reactions were determined 24 hours after alternate stimulation with stable noise, was practically unchanged.

During the second month of the experiment, gradual depression of the hippocampus was noted in the animals, but by the 60th day thresholds of electroencephalographic and behavioral reactions, reproducible during stimulation, increased an average of 0.7±0.1 V in comparison with control tests, i.e. in comparison with tests in which the rabbits were stimulated along with the test animals, but not exposed to the noise. In the third month of the chronic test, excitability of the hippocampus was reduced even more; thresholds of induced hippocampal reactions by the end of the chronic experiment (90 days) are increased an average of 91% in comparison with control tests.

However, immediately after 3 hours of stable noise, the hippocampus was excited at all stages of the one-month experiment; the thresholds of induced hippocampal reactions were reduced an average of 0,2±0.05 V, which was statistically unreliable. During the second month of the chronic experiment these thresholds decreased an average of 0.7±0.1 V, and after the third month 1.1±0.1 V.

Thus, the prolonged effect of stable noise causes persistent depression of the hippocampus, progressing until the end of the 3-month test. In contrast, impulse noise has a pronounced exciting effect, which appears especially at the end of the 3-month experiment.

Conclusions

1. Impulse noise causes maximum increase of excitability of the hippocampus 1 hour after the effect, whereas with application of stable noise, maximum increase of excitability is noted after 3 hours.

2. Under conditions of prolonged chronic experiment, impulse and stable noise have a different effect on the functional state of the hippocampus. A stable noise stimulus causes persistent depression of the hippocampus even after the 1st month of the test. Impulse noise causes an increase of excitability of the hippocampus at the end of the chronic test.

3. Immediately after the alternate effect of impulse and stable noise, at all stages of the chronic test, excitability of the hippocampus was increased.

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